Pedestrian Detection and Tracking based on Particle Filtering using HOG Features and Neural Network

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ABSTRACT
This paper presents a neural network based approach for the detection and tracking of pedestrian. It addresses the problem of human detection and tracking in surveillance videos. This system consist of three major modules: Initially the video objects are detected using a novel temporal differencing based procedure and several mathematical morphology-based operations. On the basis of results, it was figured out that the Histogram of Oriented Gradient (HOG) and Relative Discriminative Histogram of Oriented Gradient (RDHOG) feature which were trained in the Neural Network classifiers have given a good performance within the expected process timing. Pedestrian tracking is the last part of the system. In this research we propose the tracking function which is based on the Particle filtering and a trustworthy pointing system. The movement and alteration in the size of the vehicles which are detected in continuous video frames are tracked by the function.

General Terms
Pedestrian Detection, Tracking, HOG, RDHOG

Keywords
HOG, Pedestrian Detection, Neural Network, RDHOG

1. INTRODUCTION
Pedestrian detection and tracking is one of the most popular problems in Computer Vision. It has large number of applications like surveillance, tracking path of Missiles and Rocket, movement control of recording cameras and many more. Pedestrian tracking basically constitutes of estimation of trajectory of moving target object, which is done by updating the motion model of the target. For updating the motion model algorithms like Kalman filter, Particle filter are usually employed. Kalman filter is used in case of linear motion model, whereas particle filter deal with problem of non-linearity. But both require an observation model to finally estimate the value of target. Observation model basically consist of sensor output, but to decide which observation is useful or which is futile, we need to do comparison with target object. This is done by comparing the feature descriptors. As feature descriptor HOG feature descriptors has recently gain more popularity due its less computational requirement and its invariance against various changes like color, scale and rotation. Observation model is based segmented objects that is really crucial for real time applications to avoid unwanted objects as target candidates. To identify relevant candidates recognition is done using classifier's that can recognize a desired candidate object in irrespective of its view. For this neural network classifiers are more popular as they can classify objects in more than 1 class.

2. PEDESTRIAN DETECTION USING RDHOG
The proposed method combines RDHOG based neural network and Particle filter which in turn enhances the accuracy of the detection. Initially, background subtraction with neural network based classifier is used to detect and verify objects entering the region of interest (ROI). The background image from the object is separated using the background subtraction approach which is very much in trend for this purpose.

Over a period of time, for the modelling of colour value of every pixel in an image the mixture of Gaussian distributions has been used and is proving to be a significant method for this.

3. BACKGROUND SUBTRACTION
Background is obtained by taking of average of initial frames. As the video progress we keep on averaging new frames such that we get a stable background which keeps on updating automatically. After getting background we do background subtraction. Now we obtain the moving objects. After this we apply morphological operations to objects detected to remove noise. In morphological operations we use dilation and erosion. To get contour of object we apply contour detection. Then we draw bounding box around contours. After getting objects problem of shadow arises. Usually the shadows of an object lie in the lower half of bounding box. And in case of human as an object useful features lie in upper half of body like face of human. Therefore it is better to take only upper half of body as an object to calculate features. Due to shadow width of an object gets increased; because of this background also get involved in bounding box. So we iterate the pixels of the object to remove the background from object.

Fig 1: Result of background modeling and background subtraction.

Fig 2: Result of background modeling and background subtraction.

4. NEURAL NETWORK CLASSIFICATION

After background subtraction, we need to validate the detected objects i.e. we will discard those objects which we don't want to track. This task can be achieved by neural network based classifier. Suppose we want to track pedestrians, so we have to train neural network classifier by using some feature descriptors like HOG. Here we have used RDHOG based feature descriptors. Problem with pedestrian is that, it can appear in different postures like front, back, left and right. So we have to treat each posture as a different object, which means that neural network based classifier is needs to be trained for four different classes. So for training we have collected pedestrian images of different postures standard datasets. After training, the classifier can be used to validate the objects obtained after background subtraction.

Fig 3: Sample of front view database

Fig 4: sample images of back view database

After obtaining moving objects from the frame we calculate RDHOG features for them and store features and location of objects in different arrays by assigning a label id to them. We repeat the same procedure for objects obtained in next frame. And to determine the id of new objects we compare their features with the features of object of last frame by using nearest neighbour rule. The likelihood of a new object is obtained by ratio similarity measure of HOG and RDHOG features.

5. RESULTS

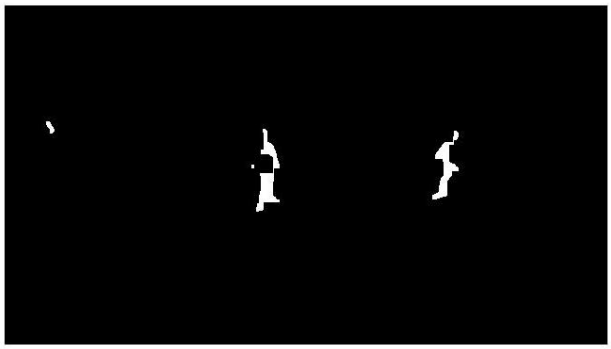

Fig 5: Output Image after Temporal Differencing and Background Subtraction

Fig 6: RGB to Gray Scale Conversion

Fig 7: Pedestrian Detection and Tracking

Table 1. Accuracy Results for HOG based and Particle filter RDHOG features

Particulars	HOG Based	Particle Filter+ RDHOG
Tp	1437	1555
Fn	220	102
Fp	256	110
recall	86.72	93.84
precision	84.88	93.39

6. CONCLUSION

A training based model for the detection of pedestrians and tracking has been proposed in this paper. An important idea brought by this thesis is using the presence of skin-colored regions to detect humans. The skin segmentation technique introduced for this purpose represents another important contribution of this article. The developed human tracking method based on a HOG-based object feature extraction and an object matching process is also an important achievement.

The performed detection and tracking experiments prove the effectiveness of the proposed technique. Its automatic character represents also an important quality that allows our technique to be successfully used for large video databases. Thus, video indexing and retrieval become some important application areas of it. This approach can also be applied in other computer vision domains, such as robotics, video surveillance and urban traffic monitoring.

The evaluation of the performance with various possible integration of the features of images and classifiers is done. It was resulted that the Histogram of Oriented Gradient (HOG)and Relative Discriminative Histogram of Oriented Gradient(RDHOG) features are basically trained on the Neural Network classifier has given the better performance comparatively with reasonable processing time.

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